PRECISION FEED MANAGEMENT – WHAT HAVE WE LEARNED?

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INTRODUCTION

Precision feed management (PFM) is a process that provides dairy producers the opportunity to improve the efficiency of nutrient use, decrease ration nitrogen (N) and phosphorus (P) content, lower feed N and P imports, decrease excretion of N and P into the environment, lower whole farm nutrient balance and improve farm profitability. The use of PFM on dairy farms is increasingly important as animal agriculture is under more pressure from environmental concerns and regulations. Water quality, nutrient runoff and emissions of ammonia and methane into air are the primary concerns. The dairy industry has already made significant progress in altering feeding programs and herd management to address these issues. However, there are still opportunities to make additional progress by increased use of PFM.

What is the potential impact of adjusting ration crude protein (CP) and P levels? A 1 unit decrease in ration CP lowers N excretion in the manure by 27.5 pounds/cow/year for a cow producing 70 pounds of milk with a dry matter intake of 47 pounds per day. This level of milk production represents the average dairy cow in New York. A reduction of ration P of 0.05% lowers manure P excretion by 8.5 pounds/cow/year. On a statewide basis, this would be a reduction of 17.1 million pounds of N and 5.3 million pounds of P excreted in manure. White and Capper (2014) used a modeling approach to examine the impact of precision diet formulation. They reported that balancing diets weekly rather than seasonally improved income over variable costs by $83/cow/year in a 300-cow herd. A margin of error in the feeding system of <1% was required to achieve this result.

WHAT HAVE WE LEARNED?

A PFM Working Group was established in New York to develop a unified approach to evaluating the impact of PFM in field research using commercial dairy herds. The initial impetus for this was the need to evaluate nutrient intake and excretion for herds located in the New York City Watershed. This group consisted of university faculty, cooperative extension agents and NRCS personnel. In addition, input was obtained from feed industry representatives. The working definition of PFM used by this group is “providing adequate, not excess, nutrients to the animal while maintaining environmental and economic sustainability through the integration of feeding and forage management.” One result was the development of PFM benchmarks that could be used as an initial evaluation of farms (Table 1). A spreadsheet was also developed to calculate these benchmarks. This spreadsheet also included milk and feed prices and calculated income over both total and purchased feed cost. Excretion of N and P in the manure was also calculated.

This approach has been used in several field studies with commercial dairy herds. Cerosaletti (2012) reported results for 34 herds enrolled between 2008 and 2011 in Delaware County. These herds decreased purchased grain by about 2 lbs./cow/day and increased forage in the ration from 59 to 65.4%. Manure P decreased by 18.6% (11 g/cow/day) while manure N was 9.8% (42 g/cow/day) lower. Milk income over purchased feed cost increased by 50 cents/cow/day.

Table 1. New York PFM Benchmarks

Benchmark	**Goal**
Forage NDF intake, % of BW	≤0.9%
Forage, % of total ration DM	≥60
Homegrown feed, % of total ration DM	≥60
Ration P, % of NRC requirement	<110
Ration CP, %	<16.5
Milk urea nitrogen, mg/dl	8 – 12
Cows dead or culled <60 days in milk, %	<8

A 2017 report contained the results for 8 herds that lowered ration P intake as a results of participating in a PFM program (Cerosaletting and Dewing, 2017). Manure P decreased by 23% (15 g/cow/day) and manure N was 7% lower (28 g/cow/day). Milk income over purchased feed cost increased by 46 cents/cow/day. Ganoe (2011) reported information from 40 herds using the PFM program. Manure P excretion decreased by 8.7% while manure N excretion went down by 6.3%. in the herds that exceeded the PFM benchmarks at the initiation of the study.

An 8-month study was conducted in 2 western New York herds using the CNCPS model (Higgs et.al., 2012). Ration CP was lowered by 1.7 units and milk urea nitrogen decreased by 2 mg/dl in these herds. Manure N excretion was decreased by 6% (28 g/cow/day) and 17.8% (89 g/cow/day). Milk production was maintained in these herds. Total daily feed cost decreased by 21 and 72 cents/cow/day. Income over purchased feed cost increased by 0.27 and 1.27 dollars/cow/day.

DELAWARE COUNTY PROJECT

Cornell Cooperative Extension of Delaware County received an agricultural nonpoint source pollution control grant to evaluate the impact of PFM on dairy herds in the Upper Susquehanna watershed. This grant was from the New York State Department of Agriculture and Markets. Ten dairy herds in Delaware, Broome and Tioga counties were enrolled in the project. This was a cost share grant and each herd provided a portion of the total grant cost. One herd was a custom heifer grower and one of the dairy herds fed 100% forage and no grain. The results contained in the following tables are from the 8 herds that fed both forage and concentrates. This project was conducted over a 3- year period. The PFM benchmark spreadsheet was used to track milk production, ration information and feed costs. Rations were formulated by the feed industry professional working with the farm. The CNCPS program was used to evaluate the initial (highest CP) and final (lowest CP) on each farm. There were 5 feed companies and 2 nutrition

consultants working with these herds. Table 2 contains information on herd size, housing and feeding system. Table 3 contains information on milk production and milk price. The milk price information is based on January 2017 data calculated from the Northeast Federal Milk Marketing Order #1

Table 4 contains information on ration CP and manure N. Ration CP decreased by 1.68% ration CP which was associated with a 61 grams per day of manure N excretion. Manure N excretion decreased by 14% (range = -5.2 to -29). Manure N excretion was 49.2 lbs./cow/year lower (range = (17.7 to 119.1). Figures 1 and 2 provide information on Income over feed cost. Feed prices used in these calculations are based on January 2017 information. The average increase in income over total feed cost was $147/cow/year (range = 62 to 299). Income over purchased feed cost had an average increase of $158/cow/year (range = 33 to 361.). The increased income over purchased feed cost in herd C is primarily related to the decrease in ration CP. In both herds F and G, the change in income over purchased feed cost is a combination of lowering ration CP and implementing a specific low group ration,

Table 2. Herd Information

Herd	Number of Cows	Housing	Milking Frequency, times/day	DHI	Feeding System
A	30	Tie-stall	2	No	Component
B	54	Tie-stall	2	No	Component
C	88	Tie-stall	2	Yes	TMR
D	76	Tie-stall	2	Yes	TMR
E	188	Free-stall	2	Yes	TMR
F	435	Free-stall	3	Yes	TMR
G	565	Free-stall	3	Yes	TMR
H	265	Free-stall	2	No	TMR

Table 3. Milk Production and Milk Price

Herd	Milk, lbs./cow/day	Milk Fat, %	Milk True Protein, %	Milk Price, $/cwt
A	50	3.92	3.02	19.34
B	65	3.9	3.1	19.46
C	65	4.2	3.3	20.46
D	75	4.6	3.6	22.31
E	74	3.8	3.2	19.77
F	86	4	3.2	19.73
G	87	3.9	3.0	19.25
H	75	3.56	3.0	18.41

Milk price is calculated for each herd using January 2017 Northeast Federal Milk Marketing order #1 data.

Table 4. Ration Crude Protein and Manure N Excretion

Herd	Initial CP, %	Final CP, %	Initial Manure N	Final Manure N	Manure N Excretion	Manure N Excretion

			Excretion, g/cow/day	Excretion, g/cow/day	Change, %	Change, lbs./cow/year
A	16.0	14.9	358	323	-9.7	28.2
B	16.3	14.9	319	282	-11.5	29.8
C	20.5	16.0	510	362	-29	119.1
D	17.1	16.0	385	344	-10.6	33.0
E	19.0	16.2	465	379	-20.4	75.6
F	17.4	16.5	456	423	-7.2	26.6
G	16.7	15.7	424	345	-18.6	63.6
H	16.9	16.2	422	400	-5.2	17.7

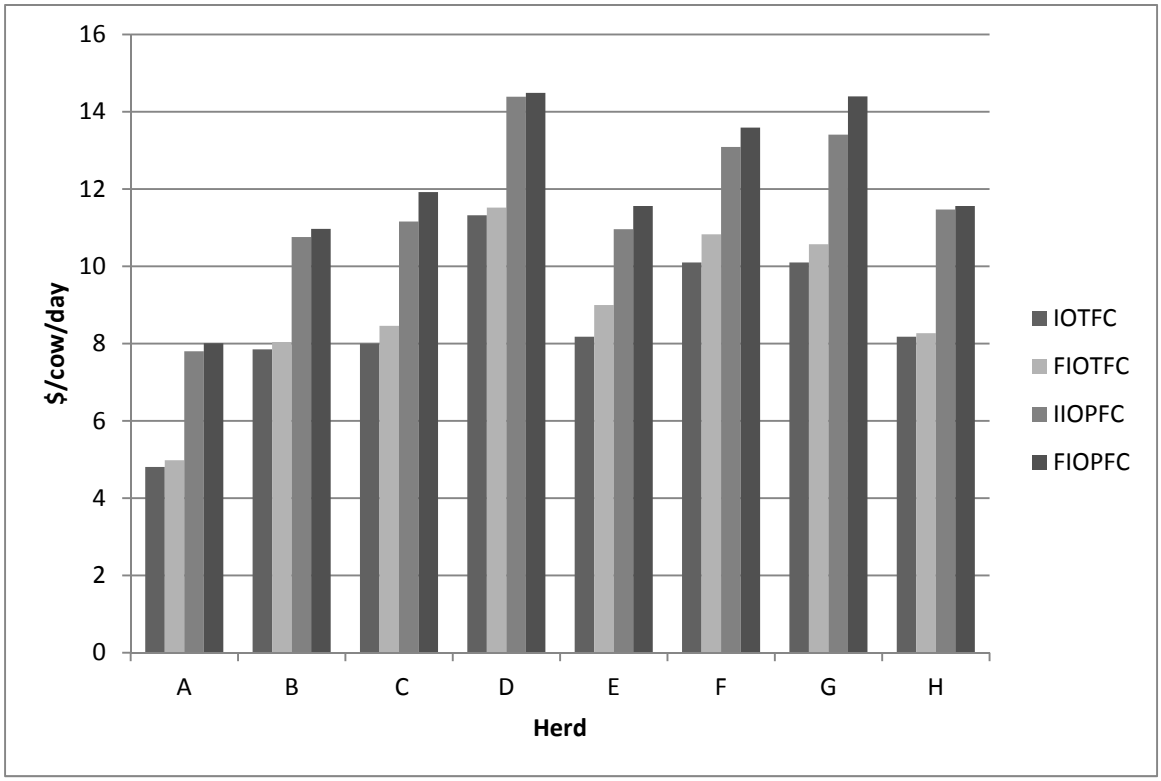

Figure 1. Income over total and purchased feed cost, $/cow/day (IOTFC = initial income over total feed cost, FIOTFC = final income over total feed cost, IIOPFC = Initial income over purchased feed cost, FIOPFC = final income over purchased feed cost)

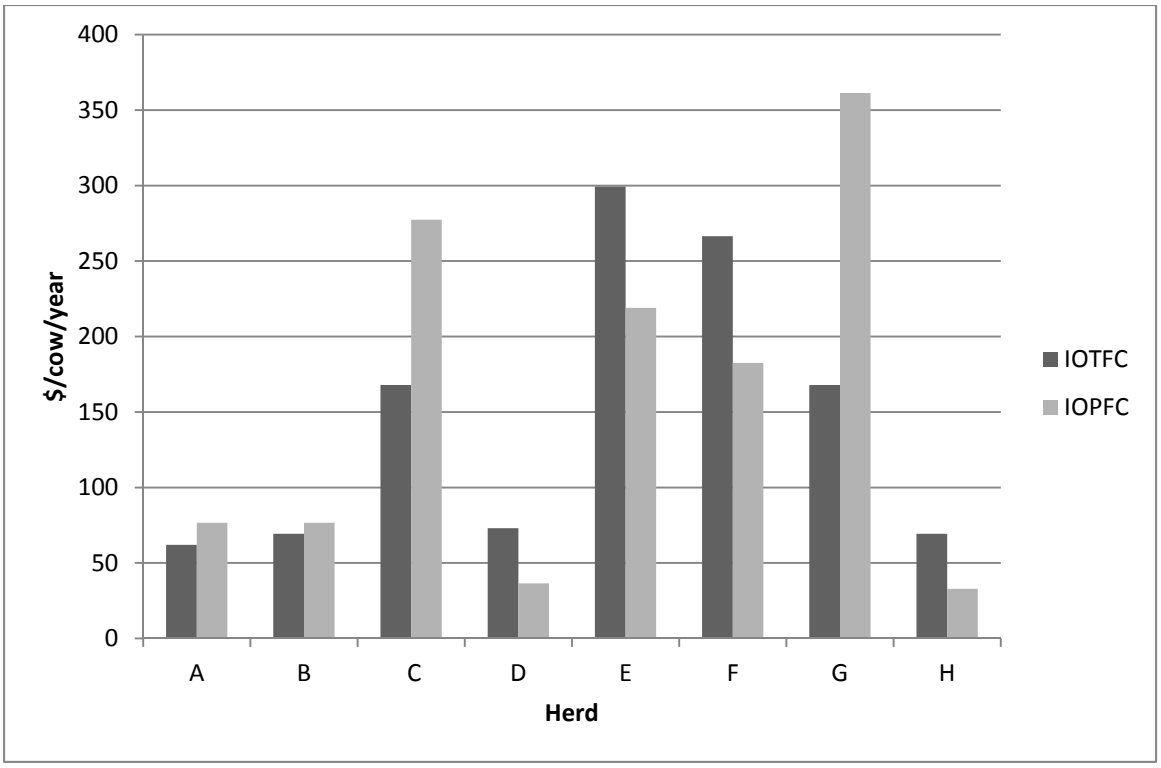

Figure 2. Change in Income over Total and Purchased Feed Cost, $/cow/year (IOTFC = income over total feed cost; IOPFC = income over purchased feed cost)

WHOLE FARM IMPLICATIONS

A whole farm modeling approach was used to evaluate PFM strategies for P farm planning strategies (Ghebremichael et. al, 2007). Two case study farms in Delaware county were used. A combination of more accurate feeding, increasing forage in the ration and improved yields of the of the grass forages lowered the whole farm P balance from 4.7 to 0.45 lbs./acre for one farm and 8.6 to 0 for the other farm. Decreasing ration P from 0.48 to 0.38% was reported to lower the acres needed for manure P application by 44% (Powell et. al., 2001).

The results of a pilot project using 2 dairy herds was reported by Cerosaletti et. al. (2003). In these herd, there was a decrease of 28% in feed P imports, a decrease of 33% in manure content and a decease in farm P mass balance from 60 to 42%. The results of a 5-year trial on a commercial dairy herd were reported (Tylutki et. al., 2004). This study incorporated changes in ration, feed management procedures, forage production and forage storage. Total animal numbers increased about 23% while total milk shipped per day increased by 45%. The percent of home-produced feeds increased from 43 to 59% and purchased N and P decreased by 37 and 40%. The shifts made in the cropping program resulted in more forage being available to incorporate into the feeding program. Daily purchased feed cost went down by 34% and manure N and P excretion decreased by 17 and 28%.

Results from a study evaluating the changes in whole farm mass nutrient balance (WFNB) on 4 New York dairy farms was recently reported (Cela et. al., 2015). These herds were used since they had 8-10 years of WFNB data. Herd milk production was maintained or improved during this time while improving nutrient use efficiency on a whole farm basis. All 4 farms lowered the CP an P content in purchased feeds, fed more closely to animal requirements and decreased manure P and N excretion. The authors indicated that precision feeding was the largest single component of the N and P changes made.

SUMMARY

The results of these studies consistently indicate that implementation of PFM practices on dairy farms can decrease purchased N and P imports, improve the efficiency of nutrient use, lower N and P excretion into the environment and improve dairy farm profitability. This requires integration of areas including ration formulation, feed purchasing decisions, feed and forage analysis, feeding management practices, forage production and forage storage. A key component for success is nthe development of a team including the dairy producer, key dairy employees, feed and crop advisors. The goal is to provide a consistent ration with minimal day to day variation.

REFERENCES

Cela, S., Q.M. Ketterings, K. Czymmek, M. Soberon and C. Rasmussen. 2015. Long-term trends of nitrogen and phosphorus mass balances on New York State dairy farms. J. Dairy Sci. 98:7052-7070.

Cerosaletti, P.E. 2012. Final Project Report: The precision feeding and forage management program. Submitted to: U.S. Army Corps of Engineers. 45 pages.

Cerosaletti, P.E. and D. Dewing. 2018. 2017 WAP Precision Feed Management Program Nutrient and Economic Report. Submitted to: NYC Watershed Agricultural Program. 11 pages.

Cerosaletti, P.E., D.G. Fox, L.E. Chase and D.C. Frazier. 2003. Precision feed management and its role in watershed protection. Proc Cornell Nutr. Conf. Pp: 251-259.

Ganoe, K. 2011. Final Report – Adoption of precision feed management benchmarks by Central New York dairy farms. Submitted to: New York Farm Viability Institute. 9 pages.

Ghebremichael, L.T., P.E. Cerosaletti, T.L. Veith, C.A. Rotz, J.M. Hamlett and W.J. Gburek. 2007. Economic and phosphorus-related effects of precision feeding and forage management on a farm scale. J. Dairy Sci. 90:3700-3715.

Higgs, R.J., L.E. Chase and M.E. Van Amburgh. 2012. Case study: Application of the Cornell Net Carbohydrate and Protein System as a tool to improve nitrogen utilization in commercial dairy herds. The Professional Animal Scientist. 28:370-378.

Powell, J.M., Z. Wu and L.D. Satter. 2001.Dairy diet effects on phosphorus cycles of cropland. J. Soil and Water Conservation. 56:22-29.

Tylutki, T.P., D.G. Fox and M. McMahon. 2004. Implemention of nutrient management planning on a dairy farm. The Professional Animal Scientist. 20:58-65.

White, R.R. and J. L. Capper. 2014. Precision diet formulation to improve performance and profitability across various climates: Modeling the implications of increasing the formulation frequency of dairy cattle diets. J. Dairy Sci. 97:1563-1577/